[Title of the Invention]

PROCESS FOR MANUFACTURE OF LIQUID CRYSTAL PANEL

[Abstract]

[PURPOSE]: Provided is a process for manufacture of a liquid crystal panel without a spacer scattering process and, at the same time, having high display quality of the liquid crystal.

[CONSTITUTION]: Adding spacer 11 to liquid crystal 5 then one drop-filling the prepared liquid crystal on a substrate can be employed in replacement of the spacer scattering process. Further at the time of one drop-filling the liquid crystal 5, the liquid crystal 5 are one drop-filled on the base 1b while changing one drop-filling spaces 6, 7 based on aspect ratio of spreading form of the one drop-filled liquid crystal 5 caused by cross-angles generated by orienting directions 4a, 4b, respectively. Otherwise, this liquid crystal 5 is one drop-filled in the form of hexagonal symmetry. By the process described above, the spacer 11 disperses evenly into a liquid crystal panel so as to improve display quality. In addition, color spacer is added into the liquid crystal 5 to perform the one drop-filling of the liquid crystal 5. Optical leak phenomenon of the spacer thereby disappears so as to improve the display quality.

[Scope of claims]

[Claim 1] A process for manufacture of a liquid crystal panel comprising: one drop-filling liquid crystal mixed with spacer on at least one among two sheets of substrates orientation processed while changing one drop-filling spaces based on a spreading form of the one drop-filled liquid crystal caused by cross-angles generated by orienting directions for the two substrates, respectively; facing the two substrates each other and overlapping together; and curing a sealant.

[Claim 2] The process according to Claim 1, wherein the one drop-filling spacing is changed based on an aspect ratio of the spreading form of the one drop-filled liquid crystal.

[Claim 3] A process for manufacture of a liquid crystal panel comprising one drop-filling liquid crystal mixed with spacer on at least one among two sheets of substrates in the form of hexagonal symmetry; facing the two substrates each other and overlapping together; and curing a sealant.

[Claim 4] A process for manufacture of a liquid crystal panel comprising one drop-filling liquid crystal mixed with color spacer on at least one among two sheets; facing the two substrates each other and overlapping together; and curing a sealant.

[Detailed Description of the Invention]

[0001]

[Industrial Application]

The present invention relates to a process for manufacture of a liquid crystal display panel in a liquid crystal display device carried in electronic calculator, word processor, etc.

[0002]

[Description of the Prior Art]

Liquid crystal display is generally used for a clock, a calculator, a word processor, etc. with advantages such as thin film shape, lightweight, and low power consumption. Moreover, in recent years, it needs increasingly a display of large display capacity and a large display screen with development of information related equipment. Furthermore, the liquid crystal panel with high display quality is also called for with colorization of a display.

[0003]

Liquid crystal panel used for the foregoing liquid crystal display has a construction as shown in FIG. 4, and liquid crystal 5 is sealed by a sealant 3 between substrates 1a and 1b in which the transparent electrode 10 is formed. These substrates 1a and 1b are maintained at a fixed space (hereinafter referring to as a gap.) by a spacer 11, and, generally are 5-10 micrometers. Moreover, white color materials such as a polystyrene system resin ball(for example, micro pearl (product available from Sekisui Fine chemical)) is used for the spacer 11.

[0004]

There is an approach for manufacture of the liquid crystal panel described above including two processes, for example, (1) a vacuum injection process comprising a sealant 3 and a spacer 11 placed in a gap between two sheets of substrate 1a and 1b prepared beforehand, then combining the substrates together into a panel assembly; contacting liquid crystal to an inlet formed on a part of the sealant 3 in the panel within a tank at a vacuum pressure; returning the vacuum pressure inside the tank to an atmospheric pressure; and charging the liquid crystal 5 in the panel; and (2) an overlapping process comprising superposing the substrate 1a formed with the sealant 3 and the other substrate 1b one drop-filled with the liquid crystal 5 after mixing the

spacer 11 to the liquid crystal in the vacuum pressure (see Japanese Laid-Open No. 62-89025)

[0005]

[Problems to be Solved by the Invention]

However, the foregoing approaches in the prior arts had the following technical problems.

[0006]

The process (1) has a drawback that if the display area of the liquid crystal panel becomes large, charging of the liquid crystal takes time too much (for example, for a liquid crystal panel of 12 inch size, it takes 30 minutes or more).

[0007]

On the other hand, in case of the second process (2), it can fill up the liquid crystal in a shorter time than of the first process (1) since the liquid crystal can be sealed while adhering and combining two sheets of the substrate together.

Moreover, since a spacer is mixed into the liquid crystal in advance, a spacer scattering process can be eliminated, thereby resulting in more effective manufacture of panel. However, the manufacturing process (2) has seldom included examination of liquid crystal one drop-filling configuration.

[0008]

More particularly, the one drop-filled liquid crystal tended to spread molecules along a rubbing direction to orientate them to a constant direction and, the liquid crystal 5 spread in the form of an ellipse as shown in FIG. 6 and, in a combined vector direction of two rubbing directions 4a and 4b for the two substrates. A longer axial direction of the ellipse is a partial direction of the combined vector, that is, the smaller one (hereinafter referring to as the combined direction A) among cross angles to the

directions 4a and 4b given to two substrates, and a shorter axial direction of the ellipse is the other partial direction of the combined vector, that is, the greater one (hereinafter referring to as the combined direction B). Likewise, the spacer 11 mixed into the liquid crystal 5 also migrates in the elliptical form. Therefore, when the liquid crystal was one drop-filled in a simple lattice (the dropping interval 6 of the combined direction A and the dropping interval 7 of the combined direction B are equal in drawings) so that the one drop-filling points in four adjacent directions as shown in FIFG. 5 become at equal intervals, it occurs a part without the spacer 11 in the combined direction B and the spacer 11 does not disperse homogeneously in the panel because of the liquid crystal 5 spreading in the form of ellipse. As a result, if the spacer is a typical white spacer, the bias of optical leak from the spacer will occur in a part other than the part without the spacer and it will show an inferior display quality. That is, this optical leak phenomenon is produced as a result of no movement of the spacer to the liquid crystal polarizing light. For example, as shown in FIG. 8 illustrating a pixel for two pieces, when the liquid crystal panel is applied with electric potential and displays black color in the pixel 9, the spacer 11 does not change even if the electric potential was applied. Thus, the spacer 11 with optical leak will show white clearly.

[0009]

Further, if the spacer 11 evenly disperses in the panel, there is little influence in view of practical use. Otherwise, if it has unevenness in the distribution like before, the display quality will deteriorate.

[0010]

Therefore, in order to prevent generation of the part without the spacer, it needs to increase the number of one drop-filling times but narrow the one drop-filling interval. However, a number of on drop-fillings take much time and the one drop-filling interval

is very difficult to control because amount of the one drop-filling per drop becomes small. Consequently, there is a new technical problem based on the foregoing description.

[0011]

This invention aims to develop a process for manufacture of a liquid crystal panel, which can produce the liquid crystal panel with high display quality and uniformity while removing the spacer scattering process in consideration of the technical problem concerned in conventional liquid crystal panel.

[0012]

[Means for Solving the Problem]

The present invention provides a process for manufacture of a liquid crystal panel comprising one drop-filling liquid crystal mixed with spacer on at least one among two sheets of substrates orientation processed while changing one drop-filling spaces based on a spreading form of the one drop-filled liquid crystal caused by cross-angles generated by orienting directions for the two substrates, respectively; facing the two substrates each other and overlapping together; and curing a sealant.

[0013]

The present invention further provides a process for manufacture of a liquid crystal panel comprising one drop-filling liquid crystal mixed with spacer on at least one among two sheets of substrates in the form of hexagonal symmetry; facing the two substrates each other and overlapping together; and curing a sealant.

[0014]

The present invention still further provides a process for manufacture of a liquid crystal panel comprising one drop-filling liquid crystal mixed with color spacer on at least one among two sheets of substrates; facing the two substrates each other and overlapping

together; and curing a sealant.

[0015]

[Function]

According to the present invention, the process comprises one drop-filling liquid crystal mixed with spacer on at least one among two sheets of substrates orientation processed while changing one drop-filling spaces based on a spreading form of the one drop-filled liquid crystal caused by cross-angles generated by orienting directions for the two substrates, respectively; or making one drop-filling configuration of the liquid crystal in the form of hexagonal symmetry, so that the bias of the distribution condition of a spacer can be considerably improved and the spacer can homogeneously disperse in the panel. Therefore, the resultant liquid crystal panel exhibits a remarkable improvement of optical leak in the spacer and high display quality.

[0016]

Moreover, even when the electric potential applied to the liquid crystal and the inside of the pixel was shaded, the optical leak phenomenon of the spacer can be prevented using the color spacer thereby so as to more improve the display quality of the liquid crystal panel.

[0017]

[Example]

Hereinafter, one example of the process for manufacture of the liquid crystal panel according to the present invention will be described in detail with reference to examples and accompanying drawings.

[0018]

(Example 1)

As shown in FIG. 1(a) and (b), polyimide resin was used to prepare an orientation film 2

on the transparent electrode (not shown) in two sheets of glass substrate 1a and 1b, then, a rubbing process was carried out for surface of each of them. The rubbing directions 4a and 4b are controlled as shown in FIG. 1(c) such that the smaller one among cross-angles becomes 60 degrees when both of the substrates were adhered and combined together.

[0019]

Then, a sealant 3 made of UV curing resin was applied to one of the glass substrate 1a in the form of triangle.

[0020]

In addition, liquid crystal 5 mixed with 0.3 wt.% of a white resin spacer having 6.0 micrometers of spherical diameter was one drop-filled to the other of the glass substrate 1b as shown in FIG. 1(d), on the condition which the one drop-filling interval 6 in the combined direction A of the rubbing direction is set to 8.0mm while the one drop-filling interval 7 in the combined direction B is set to 7.5mm, and it is dropped in a shape of grid. The one drop-filling interval responds to the aspect ratio of the spreading form of the liquid crystal resulting from the cross-angles caused by orienting directions of the glass substrates 1a and 1b, respectively.

[0021]

Next, the two substrates 1a and 1b were adhered and combined under a vacuum pressure, followed by irradiation of UV ray to the sealant 3 so as to cure the substrates 1a and 1b thereby to produce a liquid crystal panel.

[0022]

As known in prior arts, in case the liquid crystal mixed with the spacer was one drop-filled in the shape of a simple lattice, the liquid crystal spread in the form of ellipse while the spacer also moved in the form of ellipse as shown in FIG. 7. Since the part

without the spacer could be in the combined direction B, the bias arose in the distribution condition of the spacer and the display quality was deteriorated.

However, for the liquid crystal panel produced in the example of the present invention, the liquid crystal was one drop-filled by a predetermined narrow interval 7 for one drop-filling in the combined direction B as described above, so that the distribution condition of the spacer 11 was improved as shown in FIG. 1(e) and the spacer 11 substantially evenly dispersed in the panel. As a result, it can obtain the liquid crystal panel with improved display quality compared with conventional panels.

[0023]

In addition, regarding to the one drop-filling interval 6 in the combined direction A and the one drop-filling interval 7 in the combined direction B, it is not particularly restricted in the present example, however, desirable to set up appropriately orientation processing conditions, the amount of dropping liquid crystal, etc. since the spreading condition of the liquid crystal changes based on the cross-angles caused by orienting directions of two opposite substrates, respectively.

[0024]

(Example 2)

For the same process as in Example 1, repetitive description is omitted.

[0025]

To the glass substrate 1b prepared by the same procedure as in Example 1, the liquid crystal 5 mixed with 0.3 wt.% of a white resin spacer having 6.0 micrometers of spherical diameter was one drop-filled in the form of hexagonal symmetry as shown in FIG. 2(a). In this example, the one drop-filling points adjacent one another were 14, 15, 16 and 7.0mm. Thereafter, the substrates were adhered and combined together to form the liquid crystal panel by the same procedure as in Example 1.

[0026]

Consequently, the liquid crystal panel produced by this example exhibited that the spacer 11 homogeneously dispersed in the panel compared with the conventional panel as shown in FIG. 2(b) and the display quality has been considerably increased.

[0027]

Further, as described in Example 1, when the one drop-filling interval is changed and the liquid crystal drops based on the aspect ratio of the spreading form resulting from the cross-angles caused by orienting directions of both substrates, respectively, the effectiveness will improve further when it is one drop-filled in the form of hexagonal symmetry.

[0028]

(Example 3)

For the same process as in Example 1, repetitive description is omitted.

[0029]

To the glass substrate 1b prepared by the same procedure as in Example 1, the liquid crystal 5 mixed with 0.3 wt.% of a white resin spacer having 6.0 micrometers of spherical diameter was one drop-filled in the form of the simple lattice configuration as shown in FIG. 5 (the one drop-filling interval 6 in the combined direction A and the one drop-filling interval 7 in the combined direction B are 8.0mm, respectively). Thereafter, the substrates were adhered and combined together to form the liquid crystal panel by the same procedure as in Example 1.

[0030]

As known in prior arts, in case the liquid crystal was prepared using the white spacer, the spacer did not homogeneously disperse and the display quality deteriorated.

However, for the liquid crystal panel produced in the example of the present invention,

it used the black spacer 8 as shown in FIG. 3 (illustrated two pieces of pixel), thus, there was no optical leak from the spacer 8 even if the pixel 9 displayed black color and the display quality was considerably improved.

[0031]

In addition, it is not particularly restricted for the color in the present example, however, to exhibit the same effect even if the spacer has the color difficult to distinct, for example, blue, dark brown, etc.

[0032]

Further, the one drop-filling interval of the liquid crystal in the present invention described in claim 1 is altered based on the aspect ratio of a spreading form as described in Example 1, but is not restricted to Example 1 although it is altered based on the aspect ratio of the spreading form.

[0033]

[Effect of the Invention]

As it is clearly understood from the above, the liquid crystal mixed with the spacer is one drop-filled and the one drop-filling interval is altered based on the spreading form of the liquid crystal one drop-filled resulting from the cross-angles generated by orienting directions for the two substrates, respectively, according to the present invention described in claim 1, so that the liquid crystal panel can be produced with the spacer homogeneously dispersed and high display quality.

[0034]

In addition to the above, according to claim 3 of the present invention, the liquid crystal mixed with the spacer is one drop filled in the form of hexagonal symmetry, so that the liquid crystal panel can be produced with the spacer homogeneously dispersed and high display quality.

[0035]

Still further, according to claim 4 of the present invention, coloring the spacer can prevent generation of the optical leak phenomenon of the spacer and the display quality of the liquid crystal panel can be improved compared with the conventional panel.

[0036]

That is, respective embodiments of the present invention described above can remove the spacer scattering process without deteriorating the display quality and noticeably save the manufacturing cost of liquid crystal panel.

[Brief Description of the Drawings]

FIG. 1 illustrates one example of a process for manufacture of a liquid crystal panel according to the present invention.

FIG. 2 (a) illustrates one drop-filling pattern of one drop-filling process; and (b) is top view illustrating the liquid crystal spreading condition and the spacer distribution condition in the example of the present invention.

FIG. 3 illustrates two pixels explaining the optical leak phenomenon of the spacer on the condition of the electric potential application when the color spacer is used in the example of the present invention.

FIG. 4 is a cross-sectional view of the conventional liquid crystal panel.

FIG. 5 illustrates one drop-filling pattern of the conventional liquid crystal panel.

FIG. 6 illustrates the spreading condition of the liquid crystal.

FIG. 7 is top view illustrating the liquid crystal spreading condition and the spacer distribution condition in the conventional one drop-filling pattern of liquid crystal.

FIG. 8 illustrates two pixels explaining the optical leak phenomenon of the spacer on the condition of the electric potential application in the manufacturing approach (2) of the

conventional liquid crystal panel.

[Brief Description of Numerical symbols in the Drawings]

1a, 1b Substrate

2 Orientation film

3 Sealant

4a, 4b Rubbing direction

5 Liquid crystal

6 One drop filling interval in the combined direction A

7 One drop filling interval in the combined direction A

8 Color spacer

9 Pixel

10 Transparent electrode

11 White spacer

14,15,16 One drop filling point interval